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MEMORANDUM FOR PRS (Contractor Publication)

FROM: PROI (STINFO)

10 January 2002

SUBJECT: Authorization for Release of Technical Information, Control Number: **AFRL-PR-ED-TP-2002-007**
Gary Cheng (UAB); Curtis Johnson & Jeff Muss (Sierra), "Swirl Coaxial Injector Development, Part II:
CFD Modeling"

JANNAF JPC

(Statement A)

(Destin, FL, 8-12 April 2002)

(Deadline: 15 Feb 2002)

1. This request has been reviewed by the Foreign Disclosure Office for: a.) appropriateness of distribution statement, b.) military/national critical technology, c.) export controls or distribution restrictions, d.) appropriateness for release to a foreign nation, and e.) technical sensitivity and/or economic sensitivity.

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PHILIP A. KESSEL

Date

Technical Advisor

Space and Missile Propulsion Division

20021119 102

Swirl Coaxial Injector Development

Part II CFD Modeling

Gary Cheng, ME Dept., UAB
Curtis Johnson and Jeff Muss, Sierra Engineering, Inc.

Abstract

Injector design is crucial to obtain long life and provide high energy release efficiency in the main combustion chamber. Introducing a swirl component in the injector flow can enhance the propellant mixing and thus improve engine performance. Therefore, swirl coaxial injectors show promise for the next generation of high performance staged combustion rocket engines utilizing hydrocarbon fuels. These injectors swirl liquid fuel around a gaseous oxygen core. This work develops a design methodology, utilizing both high-pressure cold-flow testing and uni-element hot-fire testing to create a high performing, long life swirl coaxial injector for multi-element combustor use. Several swirl coax injector configurations were designed and fabricated by Sierra Engineering, and tested at the Propulsion Directorate of the Air Force Research Lab. Both cold-flow and hot-fire tests were conducted. CFD analyses have been performed to assess the ability of CFD to provide detailed insight into the flowfield and improve our understanding of the underlying flow characteristics of an optimized injector design. Both cold-flow and hot-fire analyses were completed. The CFD code utilized was the FDNS-RFV code with the homogeneous real-fluid model employed to simulate the spray combustion phenomena for both the cold flow and hot fire conditions. Initial results show that large scale phenomenology was predicted well by the cold-flow CFD analysis (see Figure 1). Detail flow-field characteristics will be compared when the CFD analyses are completed that match actual test operating conditions. The FDNS-RFV code has been widely employed by NASA MSFC to analyze various flow problems of rocket engines. Analysis and test comparisons will be presented and an assessment of the utility of the analyses will be discussed.

Mass Flux Distributions of Fuel at Various Axial Locations (Swirl Injector #1)

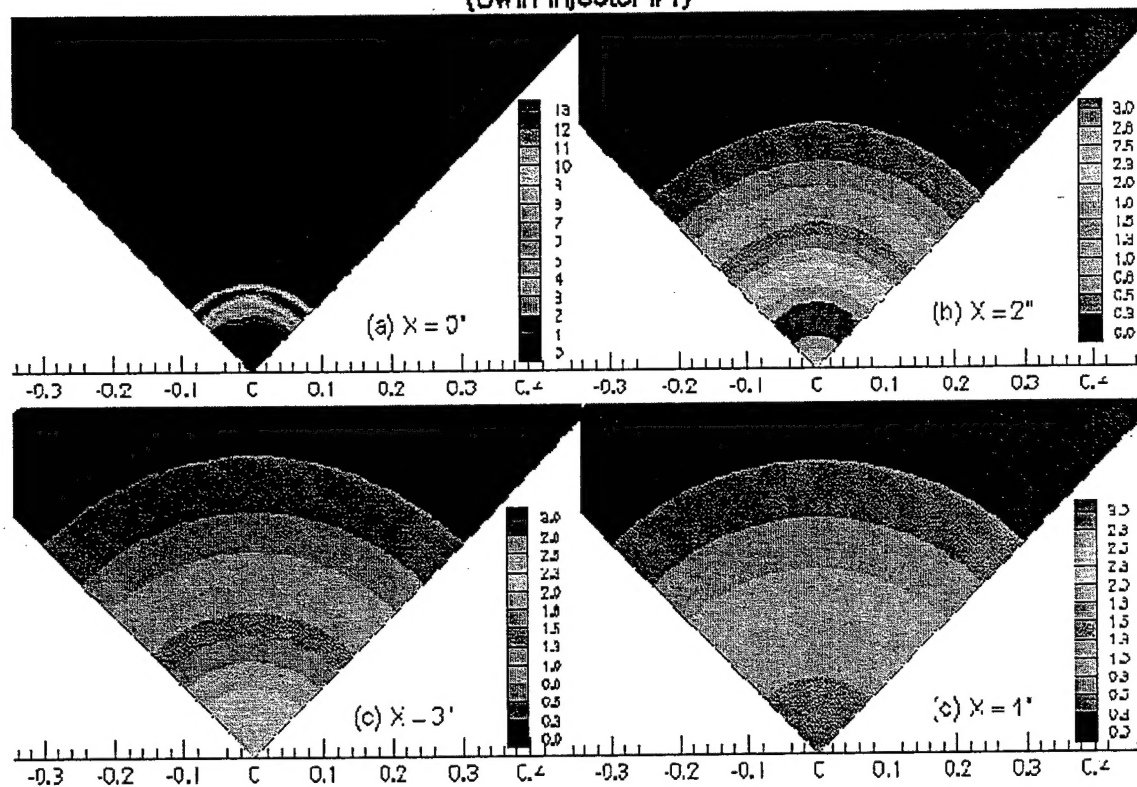


Figure 1. FDNS analysis of the Mass Flux Distribution for a Cold-Flow Injector Test.